Radiative Properties of Biological Surfaces

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INTRODUCTION

In many biological materials the energy transfer, in general, and the radiative transfer, in particular, are not well understood. The good insulation characteristics of Arctic mammals has led researchers to also study the effects of radiation heat transfer[1]. Previous research has focused on the bulk radiative properties of arctic animal fur in the UV[2]. New insight should be obtained by extending this research into the IR where most of the arctic animal radiative heat loss occurs. Advances at the ALS facility have now made it possible to measure radiative properties at sub-hair dimensions which will aid in understanding how the pelt as a whole functions. Accordingly, we have begun measuring the radial and axial radiative transmission of animal hairs as a function of both position and wavelength by using the scanning FTIR available at the Advanced Light Source (ALS). This will enable us to determine the basic radiative properties for a variety of arctic animals which will then be incorporated into analyses to determine the radiation heat transfer.

PROPOSED METHODS

Transmission and reflection measurements of single polar bear hairs in various configurations will be made. The reflection measurements will be made using a black slide; the transmission measurements will be made with a gold coated slide. Some measurements may also be suspended over a hole. The measurements will be made using the scanning FTIR microscope at beamline 4.1.3. The end station is already in place. There will be four basic configurations: axial and radial reflectance, and axial and radial transmission. The radial reflectance mode will consist of a single hair mounted on a gold coated slide. The 10 micron IR spot will be focused at approximately the hair centerline. A series of 5 micron stepped line scans will be performed normal to the hair direction at various locations.

The axial reflectance mode will require mounting possibly several hairs in a fixative and then taking approximately 50 micron slices and placing them vertically on the slide. The beam will be focused at the slide surface and several line scans will be performed crossing the hair centerline. The radial transmission mode will require mounting a single hair across the sample field in transmission mode. The beam will be focused on the hair centerline, and a series of line scans will be performed.

The axial transmission mode will require similar mounting as described for the axial reflectance except that the array of thin sliced axially oriented hairs will be fixed to a slide transparent in the IR. The beam will be focused at the sample center and a series of line scans will be performed.

PRELIMINARY RESULTS

A number of line scan transmittance measurements across a polar bear hair mounted on a gold coated slide have been performed. The results show a measurable transmittance which can be utilized in conjunction with future reflectance experiments to ultimately determine the emissivity. This will then provide us with the data that are needed to determine the radiation heat transfer.

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